What is SYNTHETIC BIOLOGY ?

The synthetic biology philosphy

Synthetic biology is the field concerned with constructing novel cells, pathways, and other biological systems. It can be seen as **engineering applied to biology**. Research activities that could be classified like this have been going on for decades, but only recently have these efforts been gathered under the common name of synthetic biology (1,4). With the increased awareness of this new field, synthetic biology research is being systematised and a **synthetic biology philosophy** has evolved (2). This philosophy is inspired by other branches of engineering, like electrical and software engineering, and is based on the idea of standardised, portable, well-characterised parts (1,2).
By creating parts that are **standardised and well characterised**, the developer makes it easier for other engineers to use the parts elsewhere without necessarily fully understanding the inner workings of the parts (1,4).

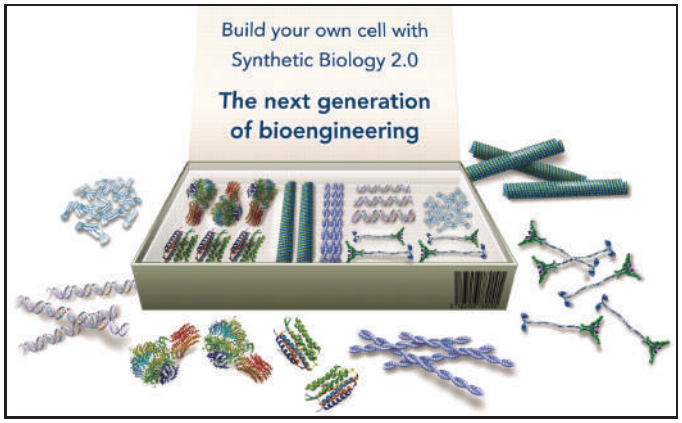

Figure 1: *Synthetic biology is concerned with creating and using a "toolbox" of genetic parts that can readily be combined and assembled into more complex systems.*

A toolbox of elements, devices and modules

Synthetic biologists categorise parts into elements, devices and modules depending on their complexity. An **element** is the smallest and simplest part, and generally does not do anything on its own. Genes, promoters and riboswitches are examples of biological elements. **Devices** are a collection of elements assembled in a way that it performs some function, for example a riboswitch regulating expression of a gene.
Modules are devices put together resulting in even more sophisticated behaviour. Several genes forming a biosynthetic pathway, or an oscillating feedback loop are modules (1). The current state of synthetic biology is mostly concerned with creating devices and modules that perform a plethora of functions. Most of these parts however have little practical use and are currently primarily of academic interest. This has been termed the **first wave** of synthetic biology (3).

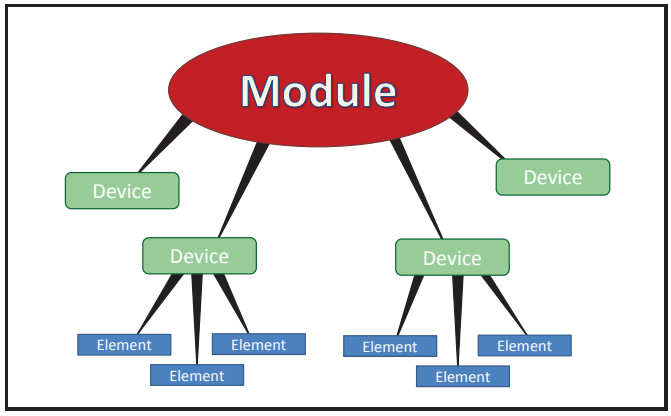

Figure 2: *Elements are the simplest genetic parts, and can be combined to form devices. Devices can then be combined resulting in modules, which can have a wide array of sophisticated functionalities.*

The **second wave** involves the development of entire systems utilising the modules created in the first wave. By combining multiple modules in a system it is possible to control several cellular functions simultaneously, and thereby build much more advanced cellular machines with many useful applications (3,4).

iGEM is a synthetic biology competition

The international Genetically Engineered Machine (iGEM) competition, is annual event where universities from all over the world participate and create novel **systems and methods** that advance the field of synthetic biology. The iGEM competition is also the worlds largest concerted synthetic biology effort, where hundreds of new innovative biological systems have been developed.

Figure 3: *Each year, the iGEM competition culminates in a jamboree where all the teams gather and present their projects, and medals are awarded to the best teams in each category.*

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References:
1. Andrianantoandro, E. et al., 2006. Synthetic biology: new engineering rules for an emerging discipline. Molecular systems biology, 2, p.2006.0028.
2. Arkin, A., 2008. Setting the standard in synthetic biology. Nature biotechnology, 26(7), pp.771–4.
3. Purnick, P.E.M. & Weiss, R., 2009. The second wave of synthetic biology: from modules to systems. Nature reviews. Molecular cell biology, 10(6), pp.410–22.
4. Wang, Y.-H., Wei, K.Y. & Smolke, C.D., 2013. Synthetic Biology: Advancing the Design of Diverse Genetic Systems. Annual review of chemical and biomolecular engineering,